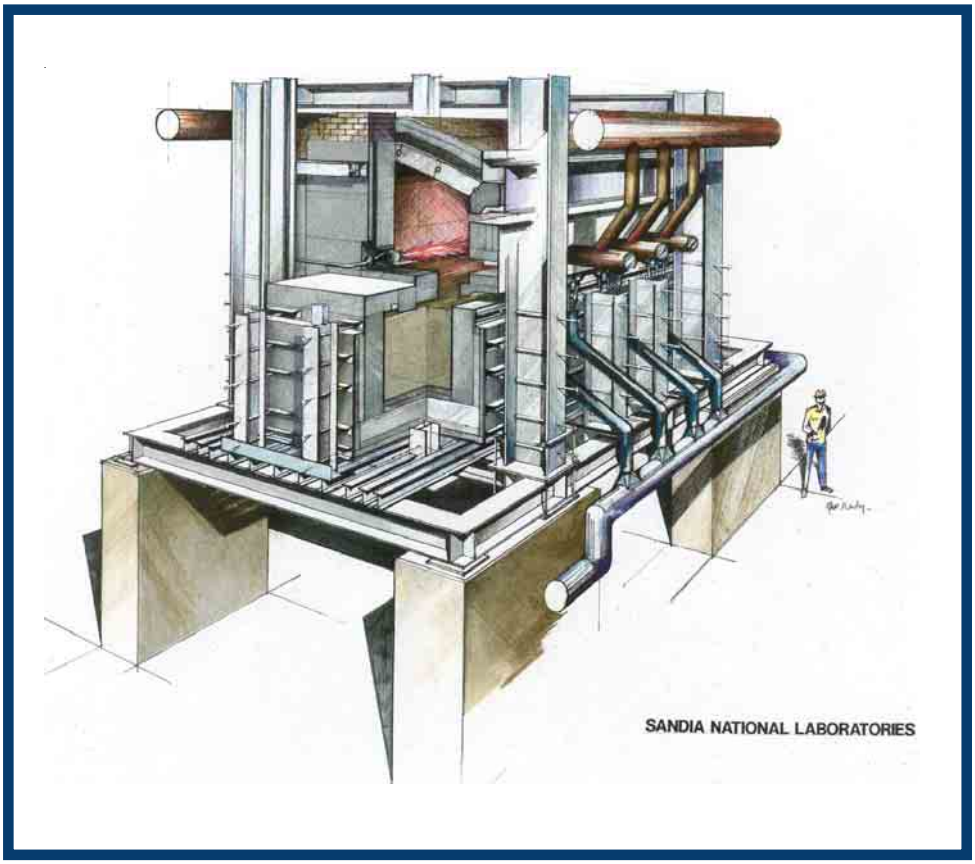
State-of-the-Art Glass Research Facility Designed To Develop Technology For Improved Melting Process Efficiency

All segments of the glass industry—flat, container, specialty, and fiberglass—concur that the industry needs a central research facility to explore technology for improving heat transfer and furnace efficiency. For example, both air- and oxygen-fired glass melting tanks have severe, high-temperature environments, making it difficult for manufacturers to maintain sensors for monitoring and controlling furnace conditions. This proposed, state-of-the-art facility would afford researchers an opportunity to address these heat transfer issues and develop techniques for tighter control of the melting process, which in turn will lead to increased production efficiency and product quality for all industry segments.



Optical and probe access is provided by ports in the breast walls, end walls, and crown, and through horizontal slots at the tuck and skew lines. Burners can be mounted in the breast walls, front end wall, and crown.

Benefits for Our Industry and Our Nation

- Improved production efficiency through the development of advanced combustion space and glass melt measurement techniques that allow tighter control of the melting process
- Increased energy efficiency and improved product quality resulting from direct measurement of combustion space conditions
- Increased furnace longevity due to measurement and control of sodium volatilization

Applications in Our Nation's Industry

The pilot-scale melting research facility would be available to industrial, university, and national laboratory scientists who wish to pursue combustion and furnace research. Since the facility's research agenda would address specific concerns identified by glass manufacturers, all industry segments could benefit from the resulting techniques and technologies.

Project Description

Goal: Design and build a state-of-the-art user facility where research and experimentation can be conducted to develop improved monitoring instrumentation for batch reactions, melt properties, combustion space conditions, and heat transfer in glass furnaces in order to improve their production efficiency.

The project approach consists of three-phases:

Phase I: Concept–perform a study of the melting tank requirements based on visits to existing furnaces and input from manufacturers to achieve an industry consensus on the type of facility needed and the research problems to be addressed.

Phase II: Engineering, construction, and commissioning of the facility.

Phase III: First investigations–provide diagnostic tools, measurements, and analysis of flows, convective heat transfer, radiation, and chemical reactions in order to improve combustion control, product uniformity, and refractory life. Initial research would likely focus on developing nonintrusive sensors using optical measurement techniques.

Project Accomplishments

Industrial recommendations were that the melting tank be made large enough to reproduce the essential processes and features of industrial furnaces yet flexible enough to be operated in as many as possible of the configurations found in industry as well as in ways never before attempted in practice. Realization of these objectives, while still providing access to the glass bath and combustion space for optical diagnostics and measurements using conventional probes, was the principal challenge in the development of the tank furnace design. The final report describes a facility having the requirements identified as important by members of the glass industry and equipped to do the work that the industry recommended should be the focus of research.

Designed the research melter to closely follow the most advanced industrial practice, firing by natural gas with oxygen. The melting area is 13 ft x 6 ft, with a glass depth of 3 ft and an average height in the combustion space of 3 ft. The maximum pull rate is 25 tons/day, ranging from 100% batch to 100% cullet, continuously fed, with variable batch composition, particle size distribution, and raft configuration. The tank is equipped with bubblers to control glass circulation. The furnace can be fired in three modes: (1) using a single large burner mounted on the front wall, (2) by six burners in a staggered/opposed arrangement, three in each breast wall, and (3) by down-fired burners mounted in the crown in any combination with the front wall or breast-wall-mounted burners. Horizontal slots are provided between the tank blocks and tuck stones and between the breast wall and skewback blocks, running the entire length of the furnace on both sides, to permit access to the combustion space and the surface of the glass for optical measurements and sampling probes. Vertical slots in the breast walls provide additional access for measurements and sampling. The furnace and tank are to be fully instrumented with standard measuring equipment, such as flow meters, thermocouples, continuous gas composition analyzers, optical pyrometers, and a video camera. The output from the instruments is to be continuously recorded and simultaneously made available to other researchers via the Internet.

Outlook

The scale of the initial furnace concept was substantially increased in response to industry recommendations. However, constraints on funding of such projects prevented the Industrial Technologies Program from providing the major support needed for construction of a research facility having this ambitious scope. It is the project team's hope that a new group of partners will emerge to carry the project forward, taking advantage of the detailed furnace design that was developed. The engineering, including complete construction drawings, bill of materials, and equipment specifications, is complete, and Sandia would be ready to begin construction as soon as quotations are updated.

Judging by the interest in the facility among glass manufacturers, and the research priorities specified in the latest version of the Glass Industry Technology Roadmap, new approaches to monitoring and control of glass production and the design of melting furnaces are seen as essential to increasing the productivity and efficiency of glass manufacturing. The Melting Research Facility would be at the center of that activity, helping to put the U.S. at the forefront of new developments in glass production.

Project Partners

Sandia National Laboratories
Livermore, CA

PPG Industries, Inc.
Pittsburgh, PA

JFM Consulting, Inc.
Pittsburgh, PA

Henry Technology Solutions, L.L.C.
Ann Arbor, MI

A. C. Leadbetter and Son, Inc.
Toledo, OH

Lilja Corp.
Livermore, CA

For additional information please contact:

Elliott Levine
Office of Industrial Technologies
Phone: (202) 586-1476
Fax: (202) 586-9234
elliott.levine@ee.doe.gov

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

CPS #1022.
June 2004